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ORIGINAL ARTICLE – HEPATOBILIARY TUMORS

Robotic Hepatic Bisegmentectomy (s4b + s5) and Hilar Lymphadenectomy for Incidental Gallbladder Cancer Using Glissonian Approach

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ABSTRACT

Background. Gallbladder carcinoma is a rare cancer with a poor prognosis and the most common biliary tract malignancy. This video shows robotic treatment of a patient with incidental gallbladder cancer diagnosed after laparoscopic cholecystectomy. The operation consisted of a robotic bisegmentectomy (liver segments 4b and 5) using a Glissonian approach and a hilar lymphadenectomy.

Methods. A 73-year-old woman with no relevant history underwent a laparoscopic cholecystectomy at another hospital facility. The pathology revealed a gallbladder carcinoma. The patient was then referred for further treatment. Pathologic revision confirmed T2a carcinoma and staging was negative for distant metastases. The multidisciplinary team decided on a radical resection that will consist of a hilar lymphadenectomy and a frozen section of the cystic stump along the resection of segments 4b and 5. A robotic approach was proposed, and consent was obtained.

Results. The operation time was 300 min and was performed 21 days after the cholecystectomy. Estimated blood loss was 120 mL with no transfusions required during or after the procedure. The postoperative recovery was uneventful, and the patient was discharged on the fourth postoperative day. The final pathology showed no residual disease in the liver specimen and no metastases among 16 removed lymph nodes.

Conclusions. The robotic approach is safe and feasible for radical treatment after incidentally discovered gallbladder cancer. The Glissonian approach is useful for anatomic resection of liver segments 4b and 5. This video can help oncologic surgeons to perform this challenging procedure.

Gallbladder carcinoma is a rare cancer with a poor prognosis and the most common biliary tract malignancy. Women are four times more likely to be affected than men.[1] The most important risk factor for developing gallbladder cancer is cholelithiasis. In the era of minimally invasive cholecystectomy, incidental gallbladder carcinoma has increased, enabling detection of early-stage cancer with a better prognosis.[2,3] In fact, it is estimated that the diagnosis of malignant disease on pathologic examination after simple cholecystectomy for suspected benign disease varies from 0.3 to 2% and often requires radical surgery to obtain adequate oncological treatment.[3–5] This video shows robotic treatment of a patient with incidental gallbladder cancer diagnosed after laparoscopic cholecystectomy. The operation consisted of a robotic bisegmentectomy (liver segments 4b and 5) using a Glissonian approach and a hilar lymphadenectomy.

METHODS

A 73-year-old woman with no relevant history underwent laparoscopic cholecystectomy at another hospital facility. The pathology revealed a gallbladder carcinoma. The patient was then referred for further treatment. Pathologic revision confirmed T2a carcinoma, and staging was negative for distant metastases. The multidisciplinary team decided on a radical resection that will consist of a hilar lymphadenectomy and a frozen section of the cystic

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stump along the resection of segments 4b and 5. A robotic approach was proposed, and consent was obtained. This study was approved by the review board of the department of surgery at our institution.

SURGICAL TECHNIQUE

Patient Positioning and Port Placement

The patient was placed in a supine and 30° reverse Trendelenburg position. Robotic surgery was performed using the da Vinci Si robotic platform (Intuitive Surgical Inc., Sunnyvale, CA). In this technique, five trocars were used. A pneumoperitoneum was created using an open technique in the infraumbilical port. Pneumoperitoneum was established at 14 mmHg. The remaining trocars were inserted under direct vision. In this technique, the surgeon sits at the robotic console, and the assistant surgeon stands on the left side of the patient. The assistant surgeon performs the retraction, suction, clipping, and changing of the robotic instruments.

Exploration of the Abdominal Cavity

After the camera is inserted, the abdominal cavity is examined for hidden peritoneal implants and severing of adhesions from previous surgery. We can see adhesions to the gallbladder bed and see no evidence of peritoneal or trocar implants. Adhesions are divided, leaving part of the omentum along the gallbladder bed. The adhesions around the gallbladder bed are divided far from the liver to avoid possible local contamination with cancer cells.

Hilar Dissection and Lymphadenectomy

An extensive hilar lymphadenectomy is performed. Dissection of the hepatic hilum is carefully performed, exposing the common bile duct, common hepatic artery, and portal vein. Cystic artery is identified and ligated near the right hepatic artery. Cystic stump is identified and ligated near the common bile duct. A frozen section biopsy of the cystic duct stump is performed and is negative. Hepatoduodenal ligament lymphadenectomy is then completed with skeletonization of the common and proper hepatic arteries, gastroduodenal artery, left and right hepatic arteries, portal vein, and common bile duct (Fig. 1).

Hepatic Bisegmentectomy (4b + 5) Using Glissonian Approach

The Glissonian approach to the liver pedicles is performed under intermittent Pringle maneuvers. The main portal vein and common hepatic arteries are clamped temporarily with vascular bulldogs for 10 minutes followed by 5 minutes of liver reperfusion. Using two small incisions at specific anatomical landmarks as described elsewhere, an articulated robotic Maryland forceps is passed around the Glissonian pedicle of segment 4b.[6] The pedicle is then controlled with Hemolock and divided with robotic scissors. The next step is to control the segment 5 pedicle (Fig. 2).

The hilar plate is detached with a blunt maneuver until the pedicle from the right anterior sector (S5 + S8) is seen.[7] Further dissection allows identification of the Glissonian pedicle of S5, which is encircled and divided between hemolocks. This leads to an ischemic delineation of the future liver resection: segments 4b and 5. Fluorescence imaging after indocyanine green injection confirms the negative imaging of both liver segments. The future line of liver transection is marked with cautery along the liver surface, using ischemic staining and fluorescent imaging as a guide. The liver parenchyma is then transected with robotic bipolar forceps under saline irrigation and an intermittent Pringle maneuver until complete resection of segments 4b and 5. The surgical specimen is placed in a plastic bag and removed through an elongated umbilical incision.

The pneumoperitoneum is restored, and the raw liver surface is checked for bleeding and bile leaks. Hemostatic tissue is applied, and the abdominal cavity is drained with a 19-F, closed-suction drain.

RESULTS

The operation time was 300 min and was performed 21 days after the cholecystectomy. Estimated blood loss was 120 mL with no transfusions required during or after the procedure. The postoperative recovery was uneventful, and the patient was discharged on the fourth postoperative day. The abdominal drain was removed at the sixth postoperative day with no evidence of bile leakage. The final pathology showed no residual disease in the liver specimen and no metastases among 16 removed lymph nodes.

DISCUSSION

Minimal invasive surgery provides superior perioperative outcomes in terms of hospital stay, pain control, and cosmesis. Minimally invasive surgery is not yet routine for the treatment of gallbladder cancer. In cases of incidental gallbladder cancer, laparoscopy has been used for staging and avoiding unnecessary laparotomy and increasing the curative resection rate. The continued advancement and standardization of minimally invasive hepatic, pancreatic,

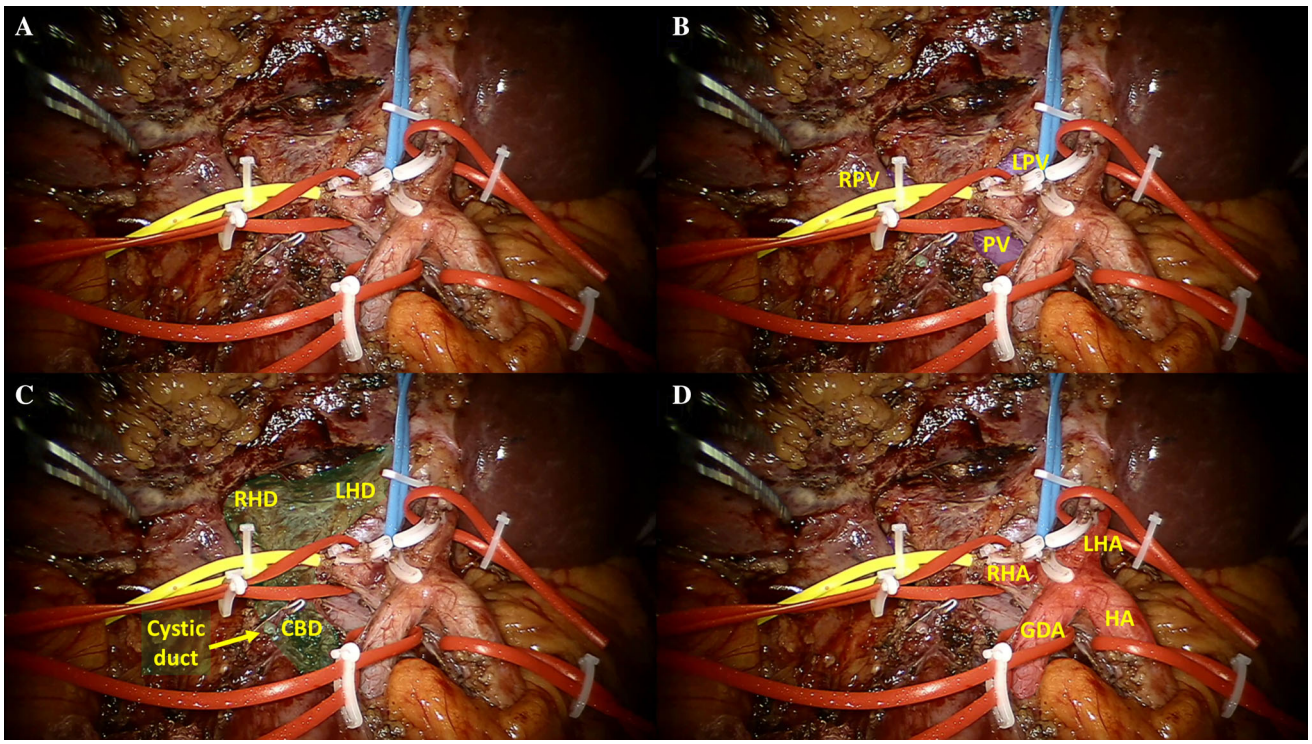

FIG. 1 Robotic hilar lymphadenectomy. **A** Intraoperative view after hilar lymphadenectomy. **B** Intraoperative view after hilar lymphadenectomy: portal vein (PV) is highlighted. **C** Intraoperative view after hilar lymphadenectomy: biliary tree is highlighted. Cystic duct can be seen (arrow). **D** Intraoperative view after hilar lymphadenectomy: arteries are highlighted. *PV* portal vein; *LPV* left portal vein; *RPV* right portal vein; *HA* hepatic artery; *CBD* common bile duct; *LHD* left hepatic duct; *RHD* right hepatic duct; *GDA* gastroduodenal artery; *LHA* left hepatic artery; *RHA* right hepatic artery

and biliary surgery suggested that the role of minimally invasive surgery in gallbladder cancer should be further explored.[8] Indeed, there is increasing interest in the use of laparoscopy and robotic approaches to treat incidental gallbladder cancer. In 2015, we published the first case of laparoscopic anatomic resection of segments 4 and 5 and hilar lymphadenectomy for incidental gallbladder cancer.[9] Since then, we have observed a significant number of publications on this topic.[8–11]

Robotic surgery continues to evolve and offers many technical advantages over laparoscopy. This can be attributed to the limited expertise and inherent limitations of laparoscopy in performing complex maneuvers in a small area. The robotic surgical system, unlike laparoscopy, provides clear three-dimensional images with improved dexterity and degrees of freedom and eliminates hand vibration. This allows surgeons to perform complex procedures, such as complete dissection of the hepatic hilum and hepatoduodenal ligament, precise suturing, bile duct reconstruction, complete lymphadenectomy, and liver resections. Since their introduction, robotic surgical systems have been enhanced with numerous technical modifications that benefit the surgeon and improve patient outcomes.

The minimally invasive technique is not oncologically inferior to the open approach, because it follows the same principles of oncologic surgery for the treatment of incidental gallbladder cancer, which should include adequate lymphadenectomy, R0 hepatectomy, and bile duct resection and reconstruction (if the frozen section of the cystic duct is positive), according to the Americas Hepato Pancreato Biliary Association (AHPBA).[12]

Cancer of the gallbladder is the most common cancer of the biliary tract worldwide and the sixth most common cancer of the gastrointestinal tract. However, adequate surgical treatment is performed in less than 20% of cases.[13] Patients with incidental tumors who undergo radical surgery have the best survival rates.[8–10] Although cholecystectomy is an appropriate treatment for T1a patients, radical resection has been shown to be beneficial for survival of patients in more advanced stages.[11,12]

Simple laparoscopic cholecystectomy is appropriate for T1a patients with clear margins and intact gallbladder, whereas extended radical resection is recommended for

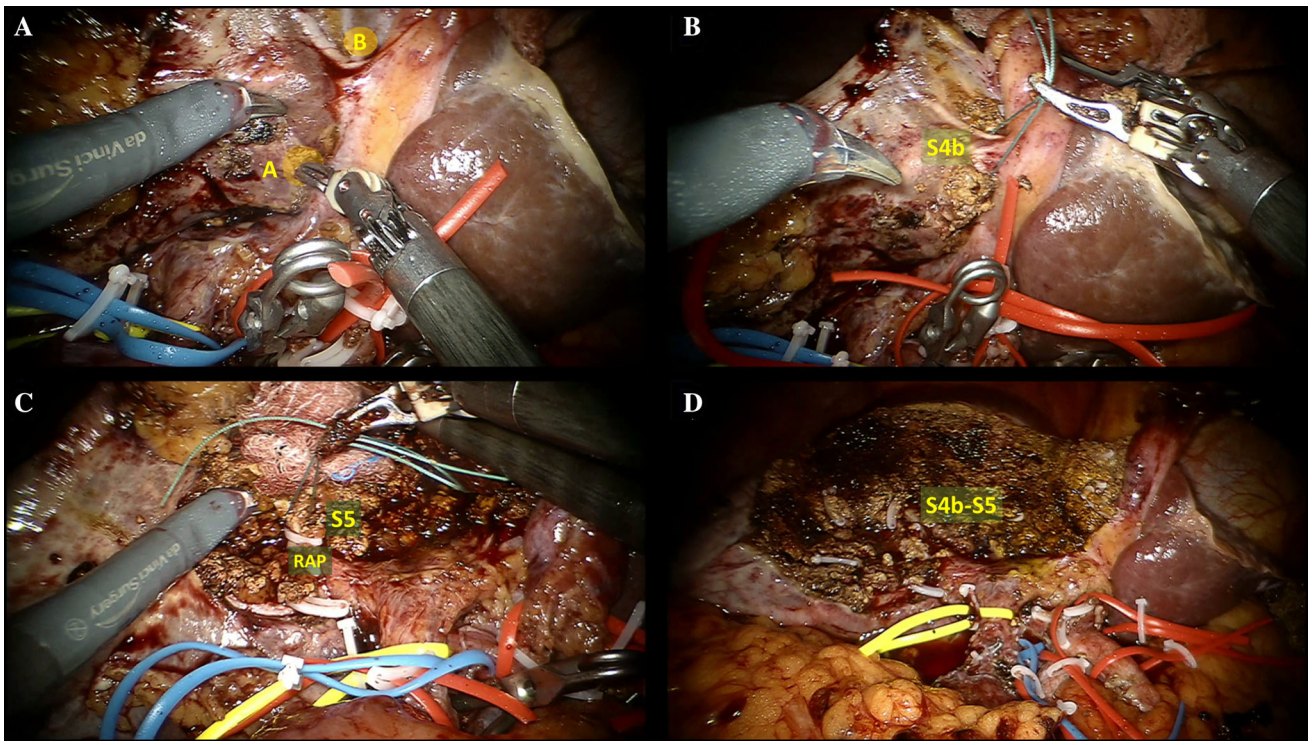

FIG. 2 Robotic Glissonian approach for hepatic bisegmentectomy (S4b–S5). **A** Intraoperative view of S4b Glissonian approach. Two incisions are made at specific landmarks (**A**, **B**). **B** Intraoperative view of S4b Glissonian approach. Robotic Maryland forceps is passed around the Glissonian pedicle from segment 4b (S4b). **C** Intraoperative view of S5 Glissonian approach. After detachment of the hilar plate, the right anterior pedicle (RAP) is identified. Pedicle from segment 5 (S5) rises vertically from the RAP, and it is encircled and divided between hemolocks. **D** Final intraoperative view after robotic hepatic bisegmentectomy (S4b–S5) and hilar lymphadenectomy for incidental gallbladder cancer

patients with T1b or more advanced incidental gallbladder cancer.[1] An intact surgical specimen and the use of plastic bags are important to reduce the risk of port site recurrence and disease relapse. Early diagnosis, careful perioperative evaluation, and precise surgery are essential factors in achieving good outcomes in the treatment of incidental gallbladder cancer.[14] Our patient was referred soon after diagnosis and was able to undergo radical surgery 3 weeks after the initial procedure.

In a systematic review, the pooled proportion of patients with unresectable disease when reoperation was attempted was 23%.[15] When feasible, further surgery with radical resection offers the only chance of cure. The standard treatment is hilar lymphadenectomy and resection of segments 4b and 5.[16,17] Lymphadenectomy of the hepatoduodenal ligament is useful for staging gallbladder cancer and may reduce the incidence of local recurrence in incidental tumors, in which lymph node metastases may be found in up to 45% of cases.[18,19] The extent of lymphadenectomy in radical GBC surgery often is limited by proximity to critical structures. Although there are no standard guidelines defining the minimum lymph node yield required, some authors have suggested a target of at least four to six lymph nodes.[12] Lymphadenectomy should ideally include removal of lymph nodes around the common bile duct, hepatic artery, portal vein, and retroduodenal region. In the present case, we were able to completely skeletonize the vascular structures of the hepatic hilum during extended lymphadenectomy with removal of 16 lymph nodes.

As previously reported, a positive margin of the cystic duct correlates with 42% of residual disease in the common bile duct.[19] Therefore, resection of the common bile duct is performed only if the cystic duct margin is positive. In the present case, the margin was negative, and resection of the common bile duct was not necessary.

Minimally invasive liver resection is associated with less bleeding, fewer complications, and better quality of life than open liver surgery.[20] Robotic hepatic bisegmentectomy (s4b+s5) could be performed using the Glissonian approach and thus in a more anatomic manner. The Glissonian approach is our preferred method of inflow control for anatomic resections, because it allows rapid control of portal pedicles while allowing segmental liver resections. The use of this approach in laparoscopic liver resection required an adaptation of the technique.[21,22] Rather than

encircling the Glissonian pedicle for individual control of the appropriate portal pedicle (as in the open intrahepatic Glissonian technique), the laparoscopic Glissonian approach was achieved with blind insertion of a vascular clamp around the target pedicle using specific anatomic landmarks.[6,7,21] The use of the robotic platform allowed safe encircling of the Glissonian pedicles of segments 4b and 5 in the same manner as originally described for open liver resection.[22]

A recent paper reviewed all of the current literature on robotic surgery for gallbladder cancer and found 74 patients in seven studies (one of which was an abstract that was later published as a full manuscript).[23,24] Of these 74 patients, 33 underwent surgery for incidental gallbladder cancer. A total of four patients (5.4%) required open conversion. Postoperative complications occurred in five of 74 patients (6.8%). There was no postoperative mortality. Of the patients in whom surgical margins were reported (n = 69), 65 patients had negative margins (94.2%), and only four patients had positive margins.[23,24] Two-year survival was reported as 60.5–100%. The authors concluded that robotic-assisted treatment of gallbladder cancer is safe and feasible but that further evidence on oncologic outcomes is needed.

CONCLUSIONS

The robotic approach is safe and feasible for radical treatment after incidentally discovered gallbladder cancer. The Glissonian approach is useful for anatomic resection of liver segments 4b and 5. This video can help oncologic surgeons to perform this challenging procedure.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1245/s10434-023-13125-y.

DISCLOSURES Drs. Machado, Mattos, Lobo Filho, and Makdissi have no conflicts of interest or financial ties to disclose.

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